TELEPHONE DIALER MODULE FOR THE LOW POWER TRI-AXIAL AMBULATORY MONITOR

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Abstract: In this paper, we present a system that allows emergency telephone calls to be made when a patient activates the alarm by pressing a button on the wireless ambulatory monitor. The system involves a triaxial accelerometer in-built to an RF (Radio Frequency) transmitter, RF receiver, telephone dialer module and a Personal Computer (PC) where data is stored for analysis.

Introduction

The telephone dialer module is to be used in conjunction with the Ambulatory Transmitter and receiver. This sub-system is part of the Home Clinical Work-Station (HCWS) which was developed by the Biomedical Systems Laboratory Depatment of UNSW. When the alarm button on the wireless transmitter is pressed, the telephone dialer will go "off-hook" and dial one of three pre-programmed telephone numbers in the micro-controller. A voice message which is stored in the dialer module will play when someone answers the call. At the end of the message, this unit will hang up. The module will the go into Auto-answer mode to pick-up any call made to the unit. The patient can them talk to the other party via the speakerphone system. Later versions of this system will have the voice communications incorporated into the wireless transceiver unit which is worn by the patient. More information about research applications for this ambulatory system can be obtained from the paper titled "A System for Monitoring Posture & Physical Activity Using Accelerometer" by M.Mathie at el. [5].

The Hardware

The Telephone Dialer Module consists of two units. As shown in Figure1 below, the receiver unit is a separate daughterboard sitting on the baseboard which has the telephone and data interface circuitry. The idea of having the receiver board separate from the baseboard, is to allow the receiver to be operated independently for applications not requring the telephone interface.

Figure 1 *Hardware of the Telephone Dialer with the RF receiver mounted*

The block diagram of the telephone interface module is shown in Figure 2. This is an improved version compared to our previous paper [6]. The front end telephone line interface uses the MH88422 Direct Access Arrangement (D.A.A.). The D.A.A. provides a complete interface between data transmission equipment and a telephone line [1][2]. The Mitel Semiconductor's MT8889C DTMF Transceiver generates the Dual Tone Multi-Frequency (DTMF) tones to dial the pre-programmed telephone number in the micro-controller [3]. This chip is also equipped with a call progress filter, which was used to monitor the line for busy and ringing tone. An AC ringing voltage across Tip and Ring will cause Ringing Voltage Loop Current (RVLC) to output a Transistor-Transistor-Logic (TTL) pulse at double the ringing frequency with an envelope determined by the ringing cadence [1]. To simplify cadence waveform, it is passed through a passive low-pass filter to create a block of square-wave before feeding it to the input of the micro controller counter. The audio circuits' has a speakerphone function to allow the patient to have a conversation. The heart of this system is the PIC16F877 8-bit Flash Programmable Micro-controller manufactured by Microchip [4]. A speech recorder is also included to play a message to the recipient of the call, just in case the patient collapse after pressing the emergency button. The audio message contains vital information such as the patient's identification number.

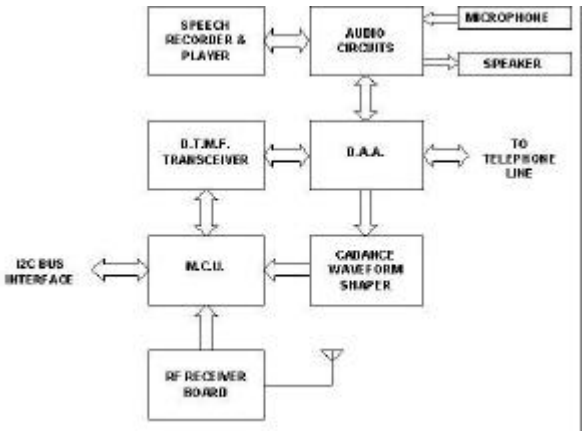

Figure 2 *Telephone Dialer Block Diagram*

The RF receiver is connected to the baseboard via an 8-way connector. It gets power and sends out data to the microcontroller via this connector. The microcontroller just collects data since the RF receiver requires no control signal. For convenience, a Light Emitting Diode (LED) was placed on the receiver to indicate that the alarm button has been p ressed.

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Abstract

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The image of the transmitter module is shown below in Figure 3. More information regarding the transmitter can be obtained from a previous paper titled "Low Power Tri-Axial Ambulatory Monitor" by R.Salleh at el. [6]. As shown, a "splatch" antenna manufactured by Linx Technologies was used on the transmitter to make the design compact. This module is then packed into a black box no larger than a typical numeric pager. It is powered up by one 1.5Volts "AA" sized alkaline cell. It is capable of running continuously for at least 72-hours on one cell.

Figure 3 *Hardware of the transmitter module*

The Software

Assembly language was used for the firmware in the PIC16F877 micro controller manufactured by Microchip. The firmware monitors the incoming packets from the RF Receiver board and synchronizes it to detect the alarm button. The data is then converted to a format suitable to be transmitted via the I2C bus. The I2C bus is used when the unit is connected to the HCWS. It has to function as a slave unit, communicating with the HCWS via the I2C bus. It is also responsible for the DTMF transceiver, DAA and telephone status monitoring. The telephone number, number of rings before answering the telephone and other configuration settings are stored in the EEPROM in the microcontroller. The EEPROM data can be modified via a Graphical User Interface (GUI) from the PC.

Discussions

The MH88422 DAA telephone line's impedance is fixed. Unfortunately, this impedance is country dependent. However there is a later version (MH8835/MH88437), which impedance can be configured to match various countries. The firmware for this system has yet to be improved to accommodate varying telephone status monitoring, e.g. busy and ringing tone. There are various telephone status monitors in the market, however, some are also country dependent. Different countries have different standards for the busy and ringing tone detection, which makes it complicated to design a firmware routine to detect all telephone call status reliably. On the other hand, the telephone dialer interface can be replaced by a voice modem instead. This will simplify the telephone interface circuits. Since it's going to be a standard voice modem, the microcontroller can "talk" to the modem using the standard ASCII commands.

Conclusion

Currently, the telephone dialer has been designed to be integrated with the Home Clinical Work-Station. This module connects to the RF Receiver, extending its capability to dial an emergency number and send a voice message when the button on the RF transmitter is pressed. There will be ongoing modifications to the design of the telephone dialer module to enhance its existing features.

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